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# Static Electric Fields and Lightning Over Land and Ocean in Florida Thunderstorms

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# Acknowledgements

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# Overview

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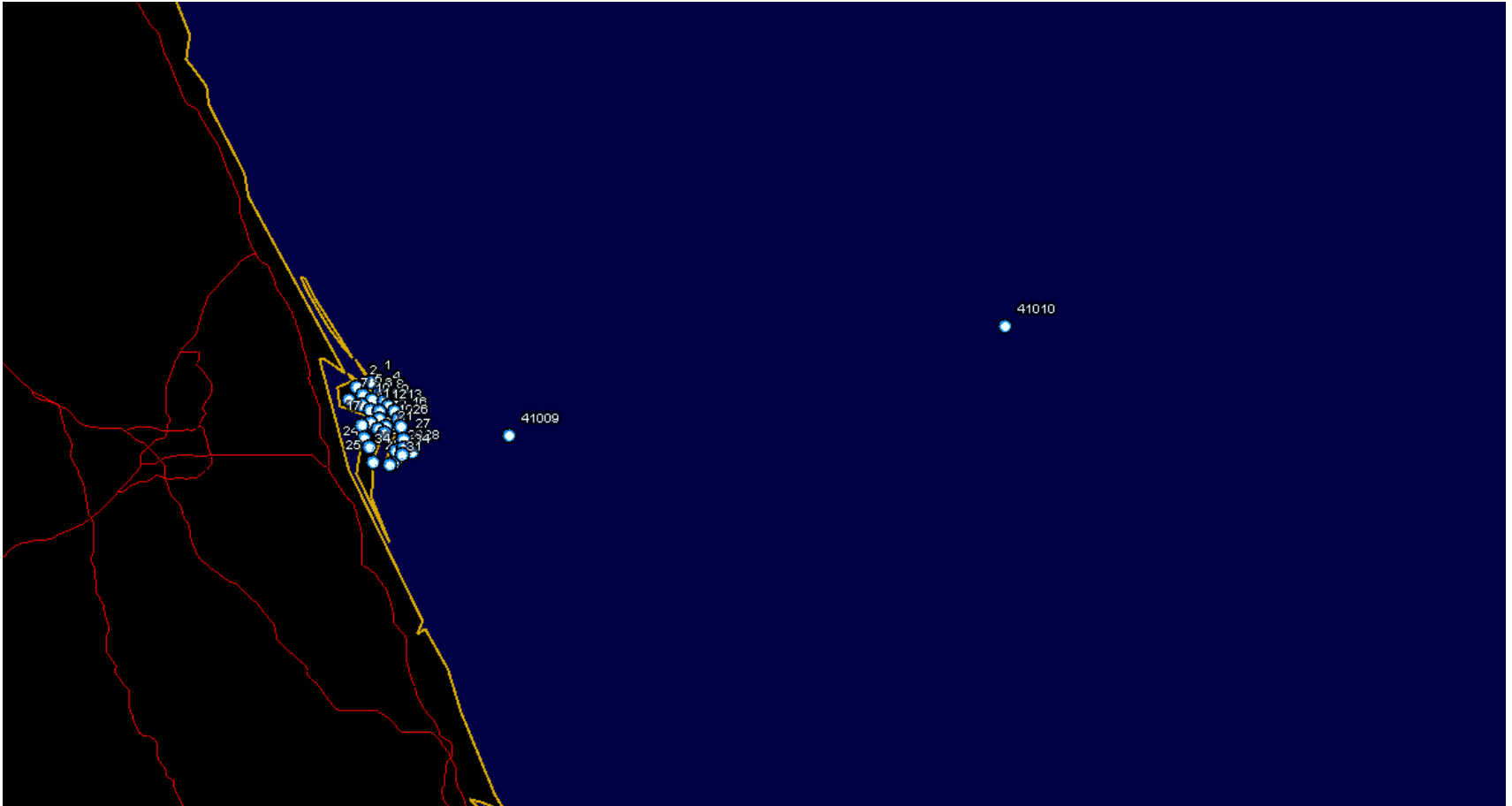
- Objective
- Peak Current Analysis
- Buoy 41009 and 41010 instrumentation Calibration
- On-shore and off-shore cell comparisons
- Conclusions

# Objective

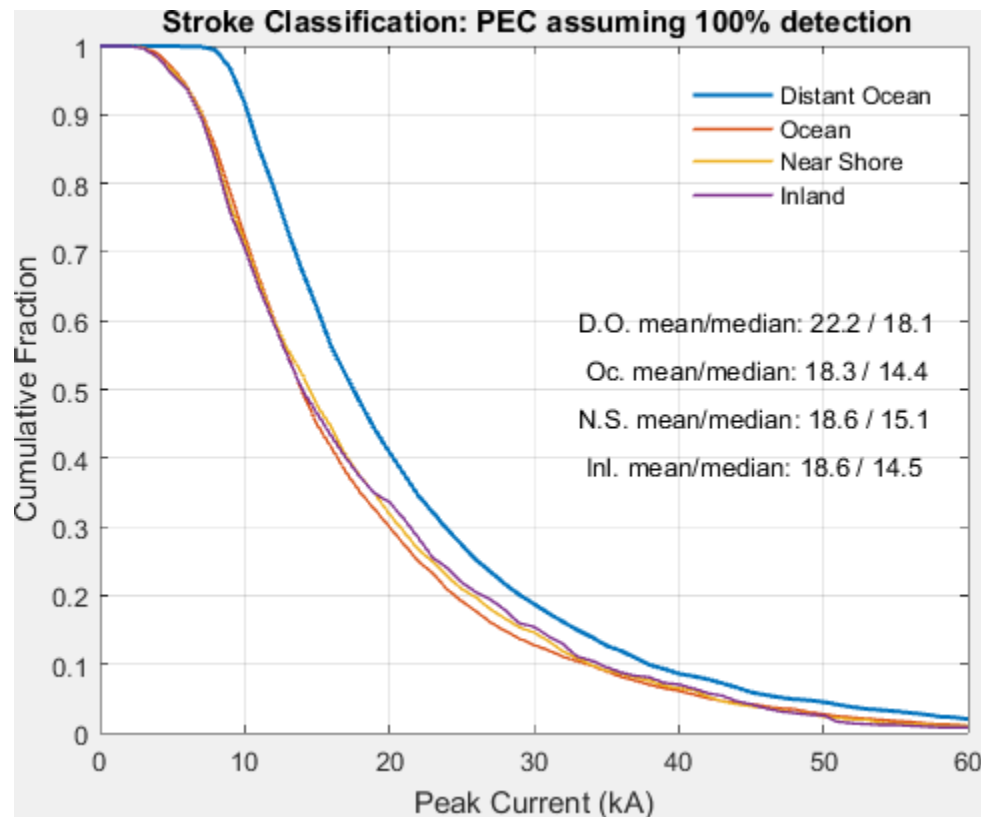
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- To test the hypotheses that natural lightning, as well as the associated electric fields over the ocean behave differently than over land
  - the peak current and fields aloft are expected to be higher
  - Potential differences in the static field magnitude and polarity as a function of range from the EFMs (differences in the magnitude of the lower positive charge region over land and ocean)

# Instrumentation Locations

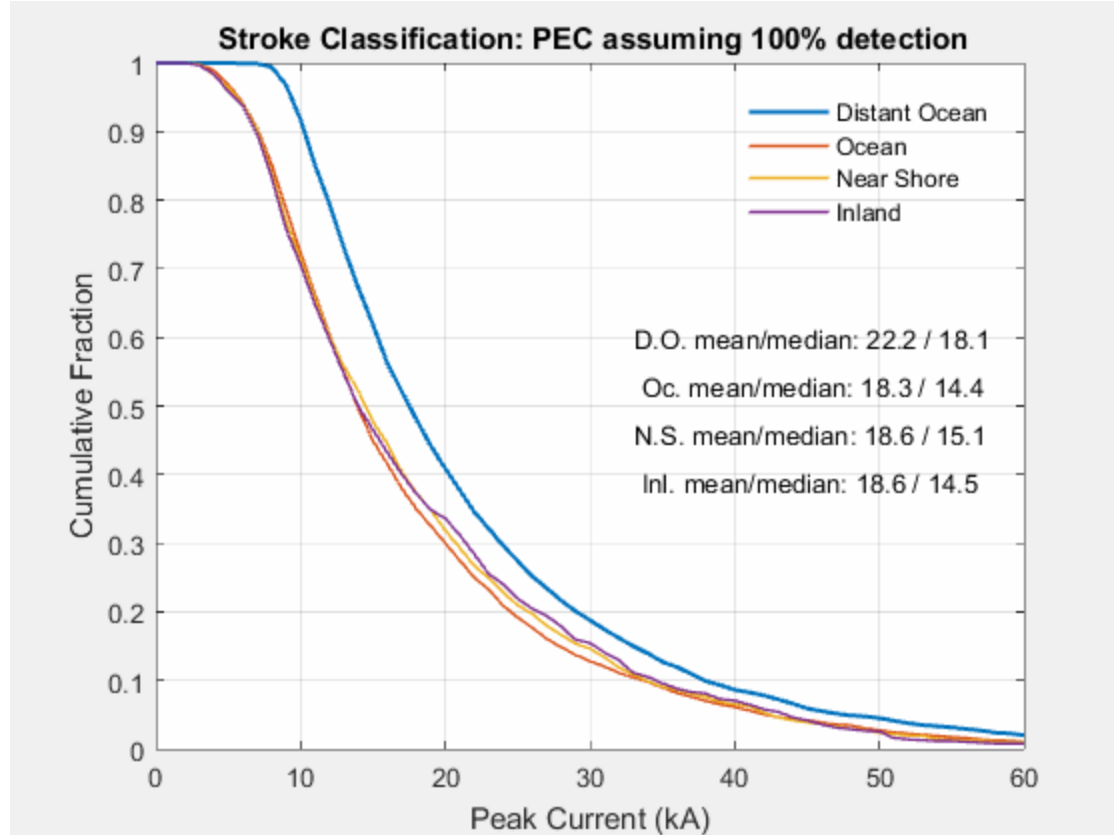


# Peak Current Comparisons



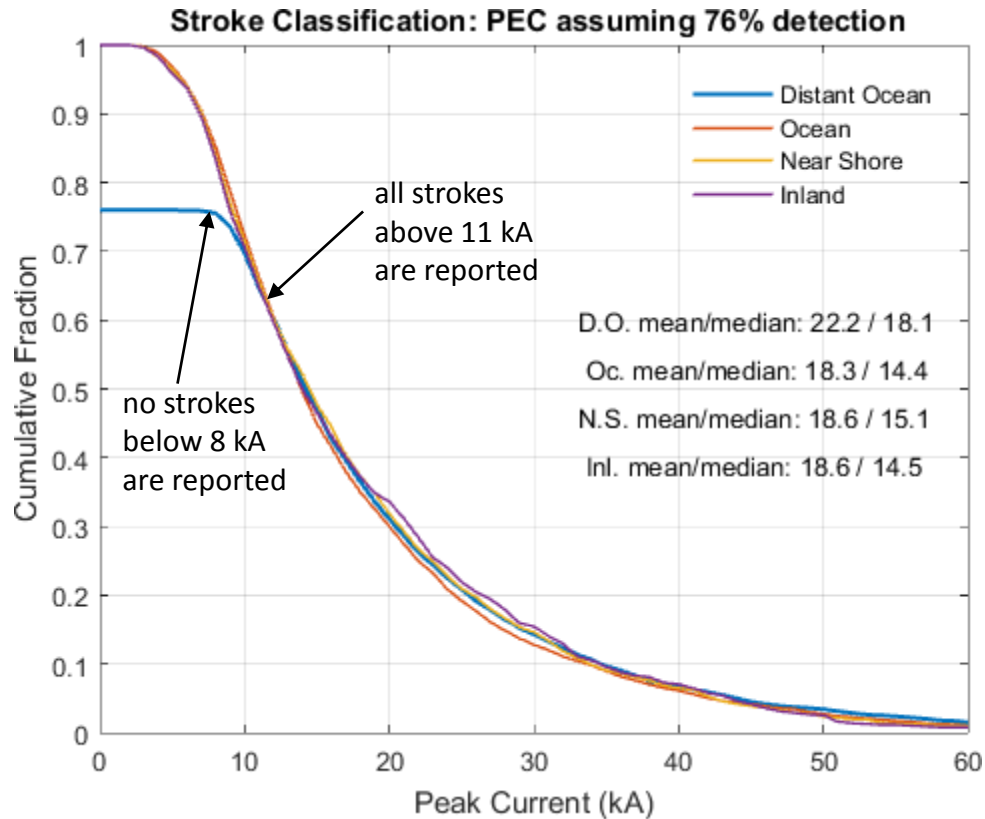
Cumulative distributions of negative CG strokes in pre-existing channels, for four different locations

# Peak Current Comparisons



Cumulative distributions of negative CG strokes in pre-existing channels, for four different locations

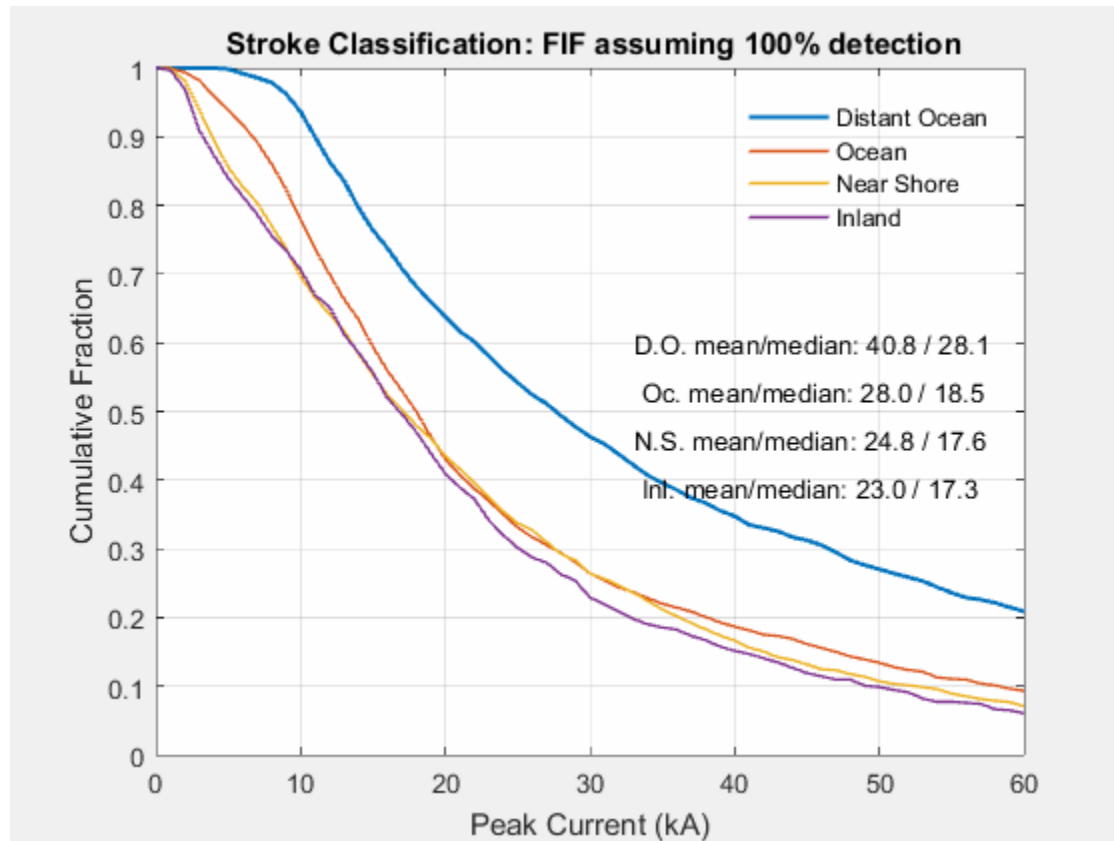
# Peak Current Comparisons



Distant Ocean distribution scaled by its effective detection efficiency.



# Peak Current Comparisons



First in Flash with the DE correction scaling set to 0.76 to match the Ocean curve between 10 and 12 kA.

# Origin of the Effect

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- What is the source of this peak current enhancement?
  - *Surface conductivity?* (  $\sigma_{\text{land}} \ll \sigma_{\text{sea}}$  )
  - *Attachment mechanism(s)?*
- Recent work points to within-cloud (Cooray et al., 2014; Nag & Cummins, 2016 AGU)
  - Shorter (20-40%) time between Preliminary Breakdown in the cloud and Return Stroke reaching the ground
    - Likely higher leader line-charge density in descending leader channels
    - Likely altered charge structure in lower portion of the cloud

# On-Shore Electric Field Mills

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- KSC Network Electric Field Mill
  - Measures fields aloft at constant rate of 50 samples/sec
  - Data uploaded to the KSC weather archive every 15 min in 30 min data folders:  
[kscwxarchive.ksc.nasa.gov](http://kscwxarchive.ksc.nasa.gov)
  - Operational network, therefore no expected data outages.



# Buoy Electric Field Meter

- Campbell Scientific Electric Field Meter
  - Measures fields aloft at variable rate of 1 sample per 10 sec during clear skies (fields below  $\pm 500$  V/m) and 1 sample per sec during elevated fields above  $\pm 500$  V/m
  - Data transmitted via Iridium modem in daily files archived for NASA
  - Mill performed well beyond expectations. No failures for 1<sup>st</sup> deployment (8 months) and 6+ months of continuous operations during 2<sup>nd</sup> deployment.



# Buoy



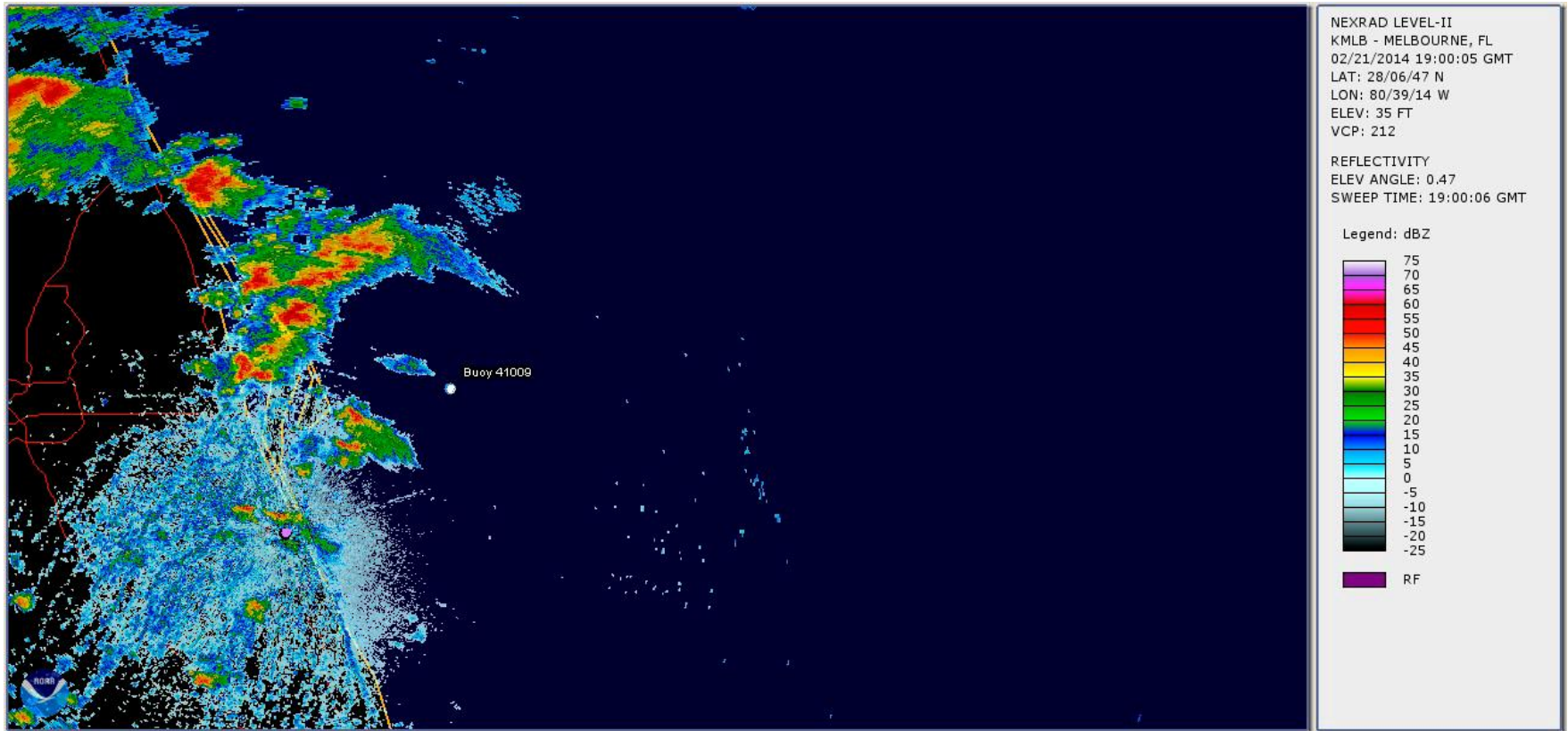
# Calibration

- Campbell Scientific calibration test stand set-up
- Buoy was the closest tall structure to calibration mill at ~50m separation
- 3 day calibration test through a frontal passage 10/21/13 – 10/23/13 while dry docked at Coast Guard Station
- Field enhancement was 1.68.

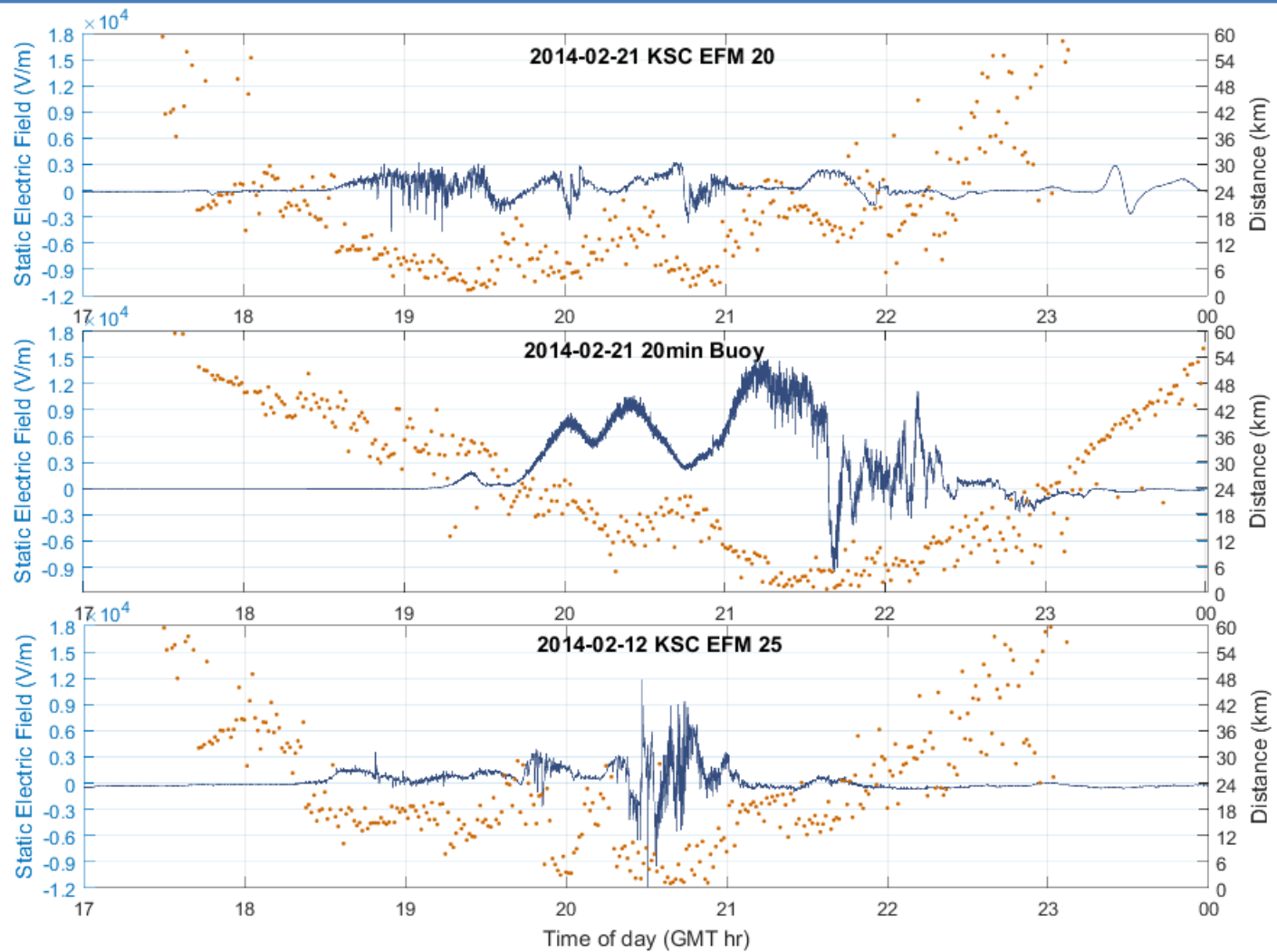




# On-shore Off-shore comparison 2/21/14

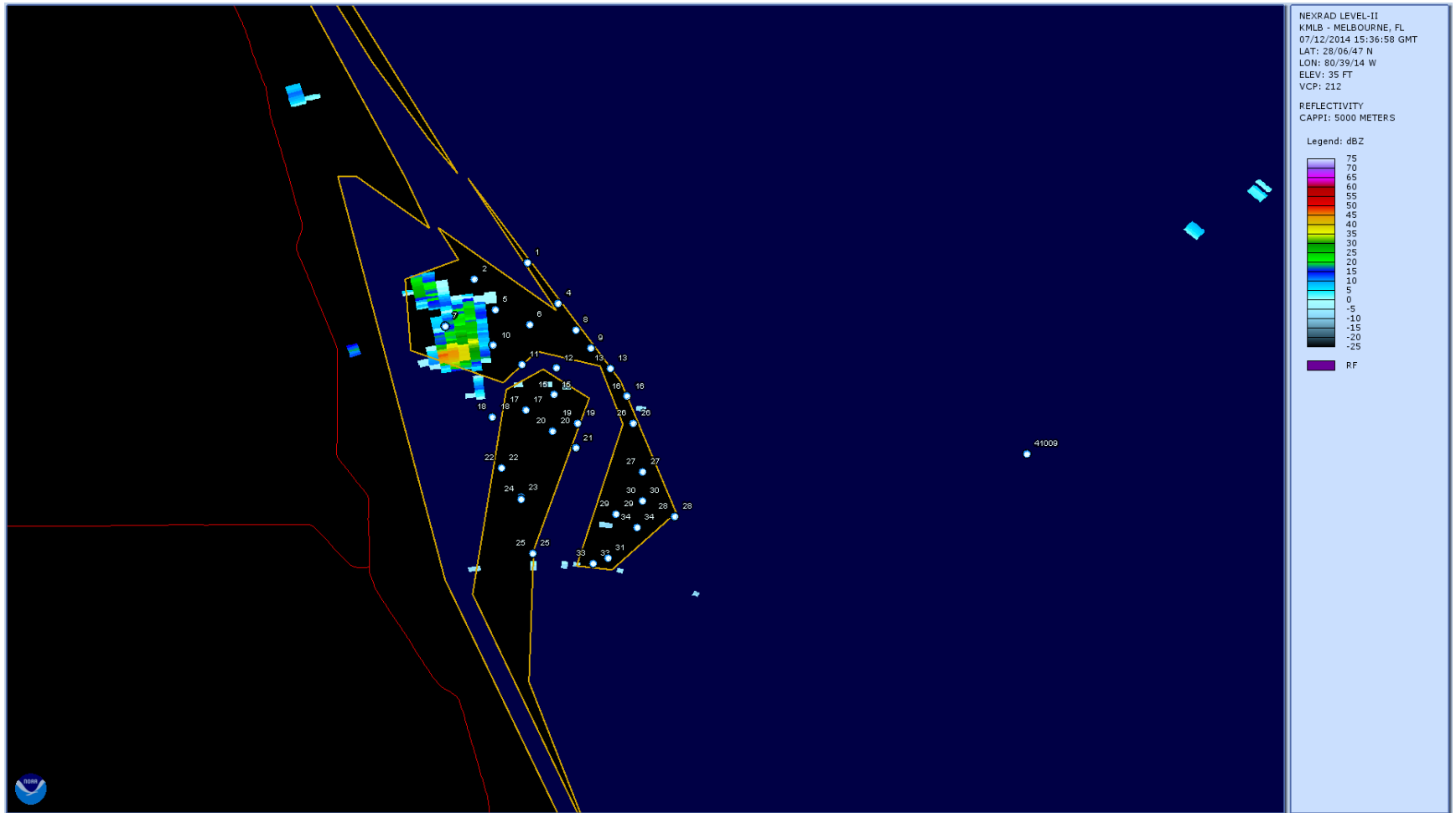


# 2/21/14

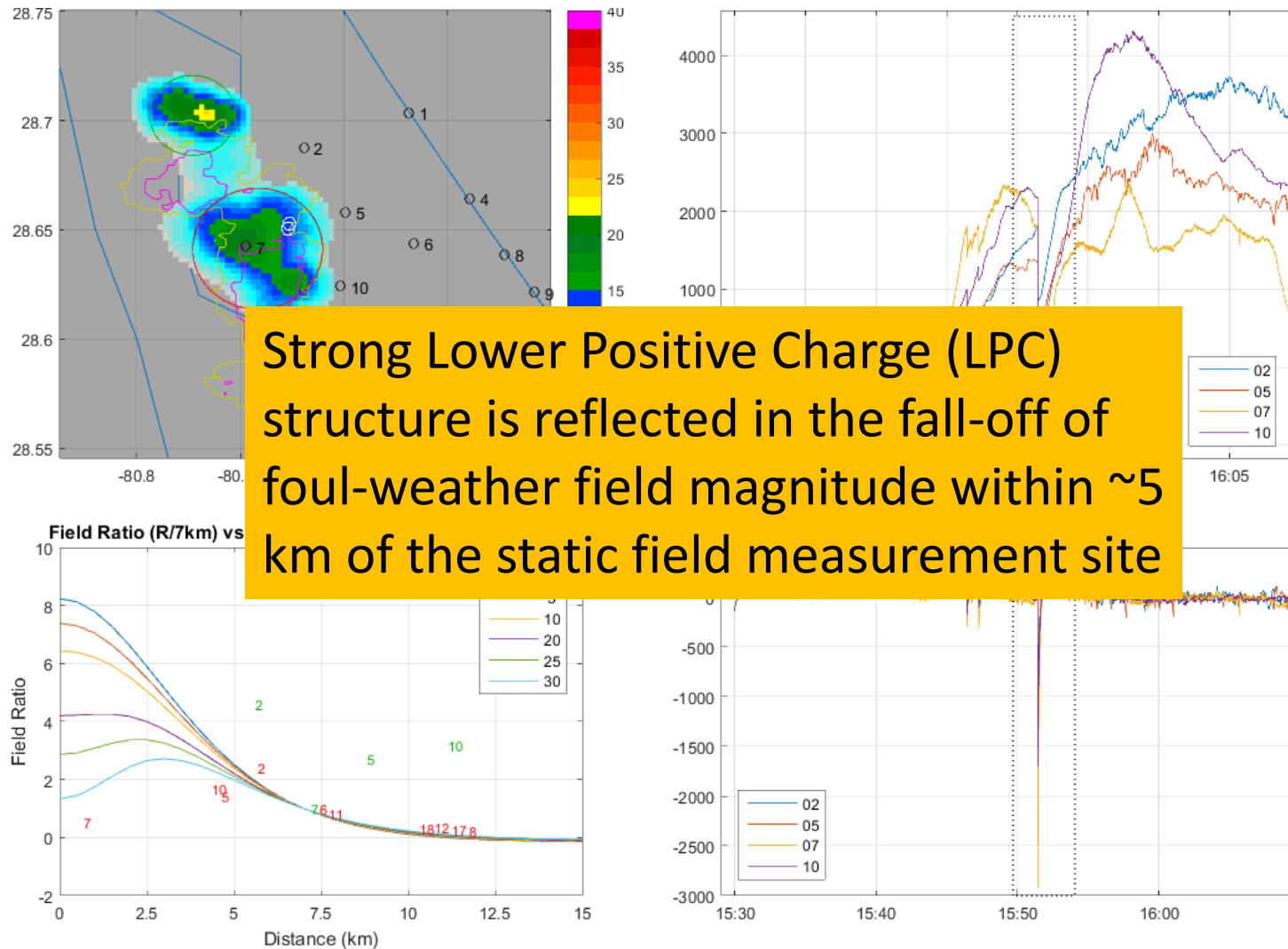




# 7/12/14 On-shore



# 7/12/14 On-shore IC Flash



NEXRAD LEVEL-II  
 KMLB - MELBOURNE, FL  
 06/25/2015 15:36:21 GMT  
 LAT: 28/06/47 N  
 LON: 80/39/14 W  
 ELEV: 35 FT  
 VCP: 11

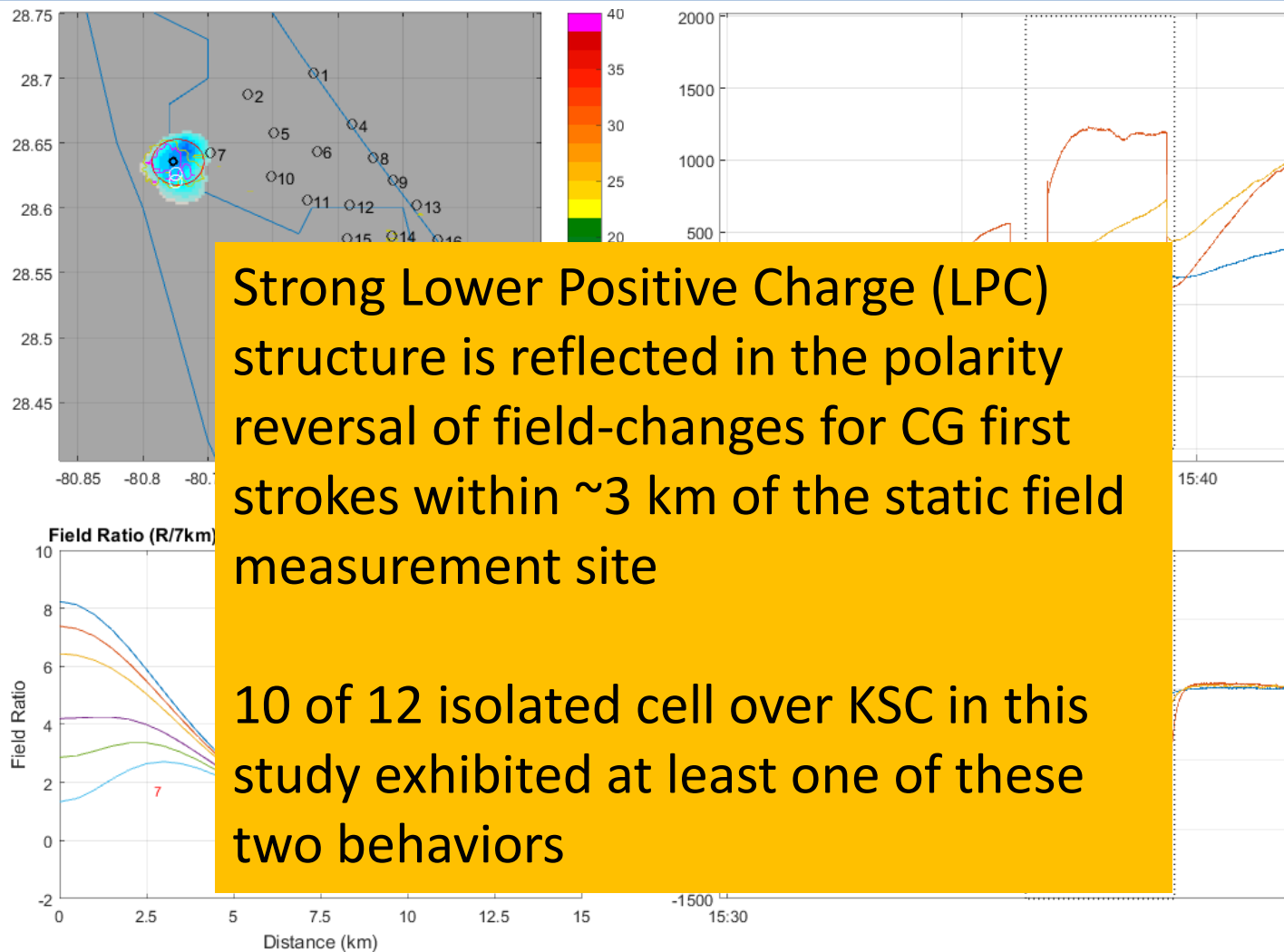
REFLECTIVITY  
 CAPPI: 5000 METERS

Legend: dBZ

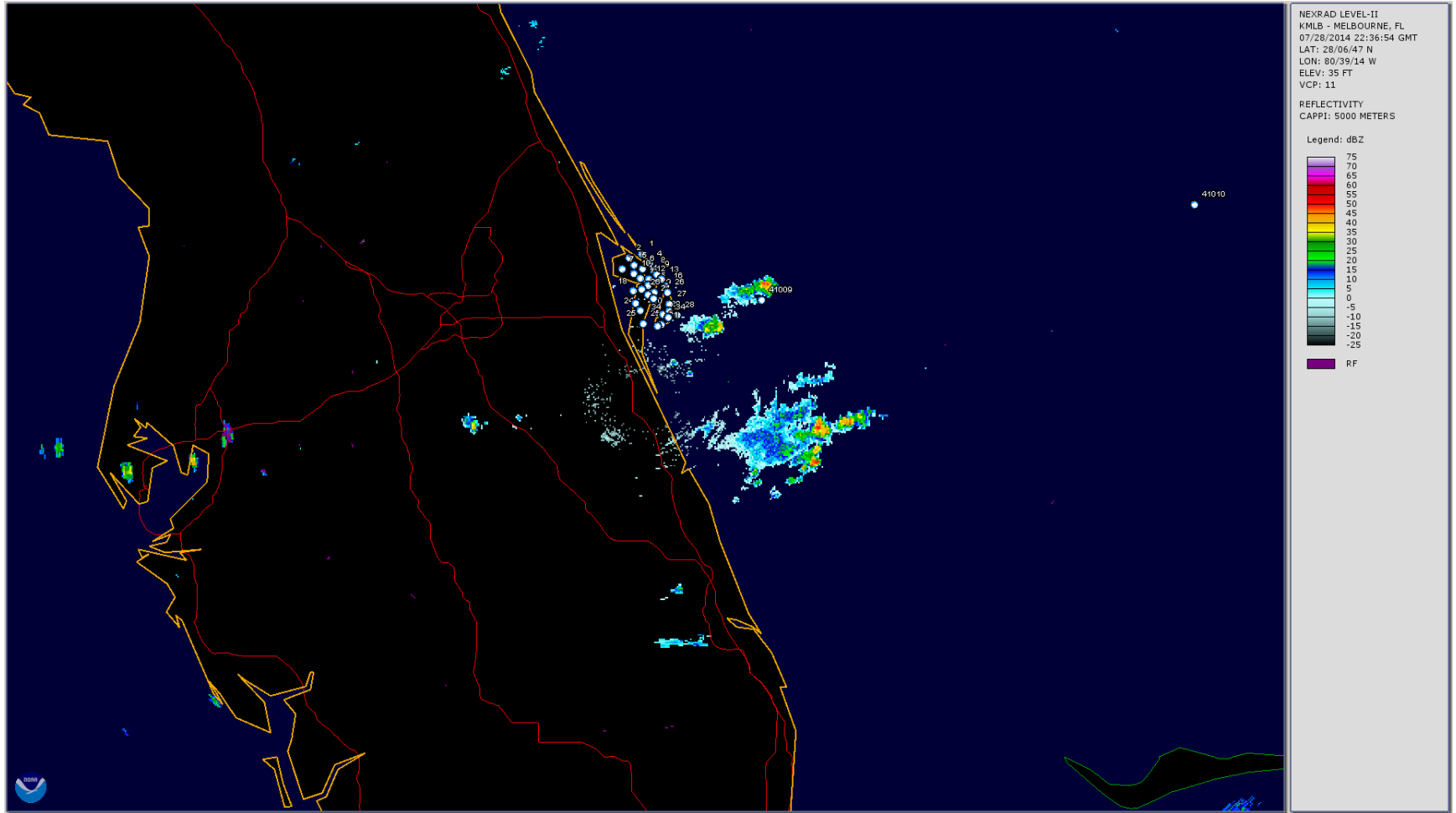
75
70
65
60
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0
-5
-10
-15
-20
-25

RF

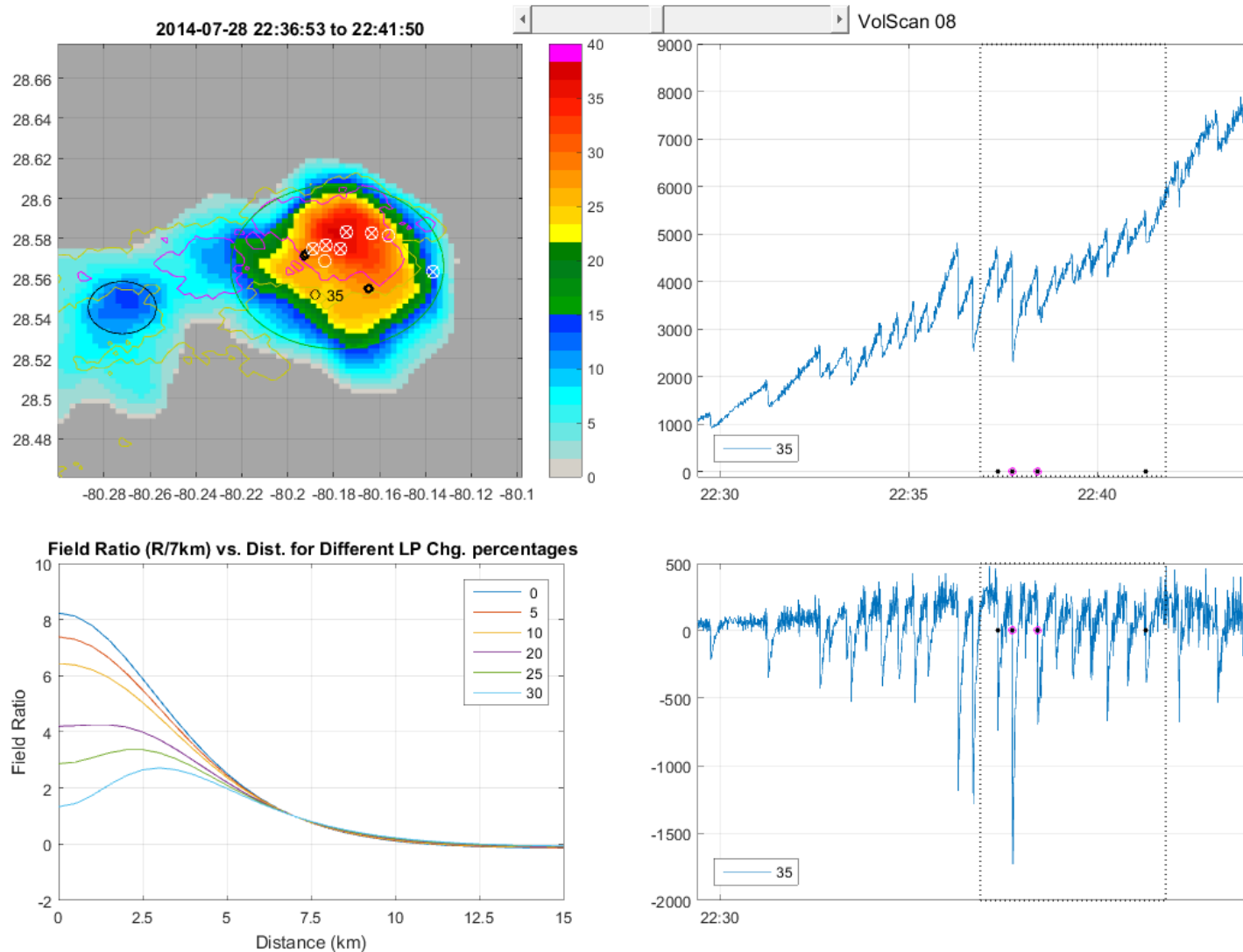
# 6/25/15 On-shore CG Flash



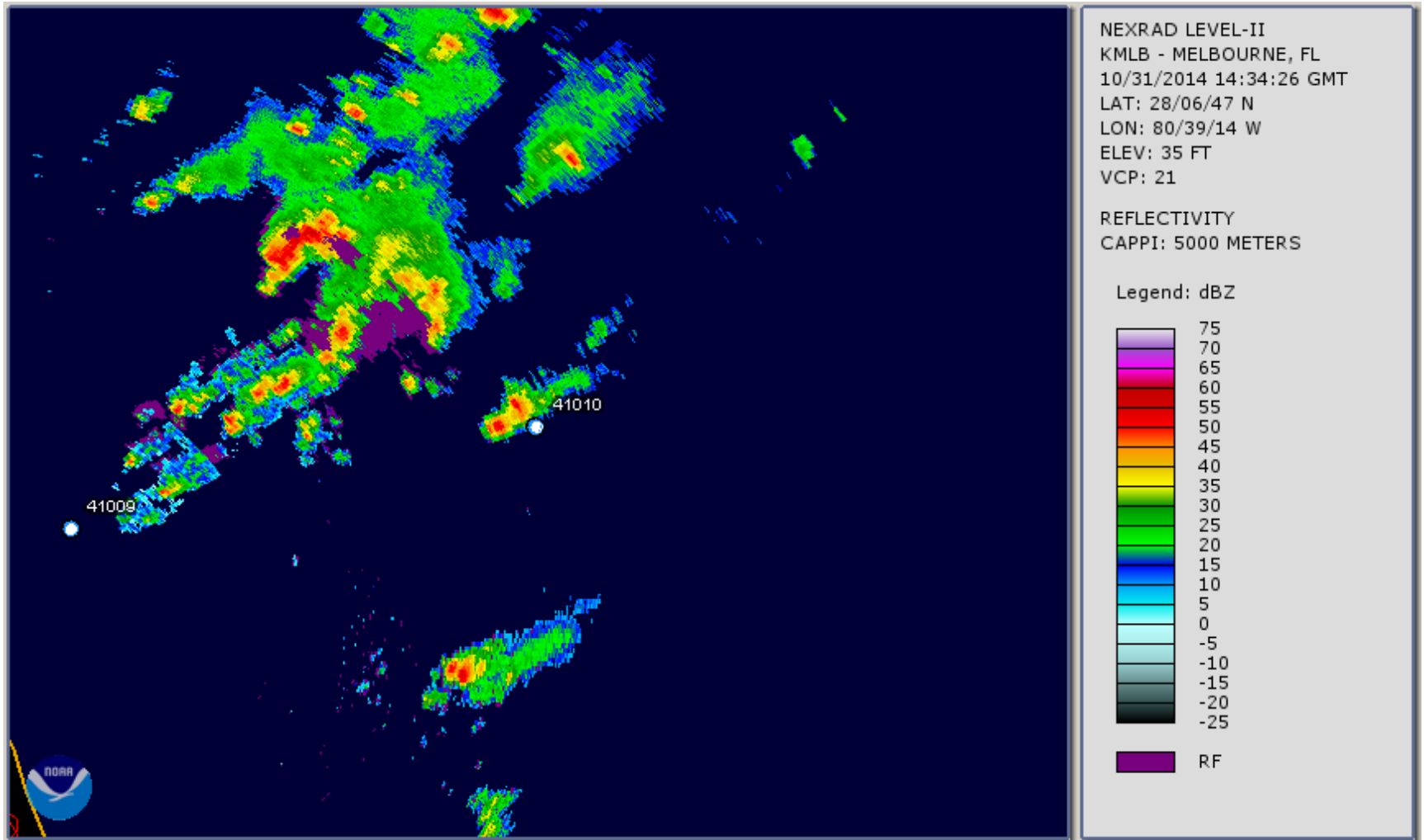
# 07/28/2014 Ocean (20 mi)



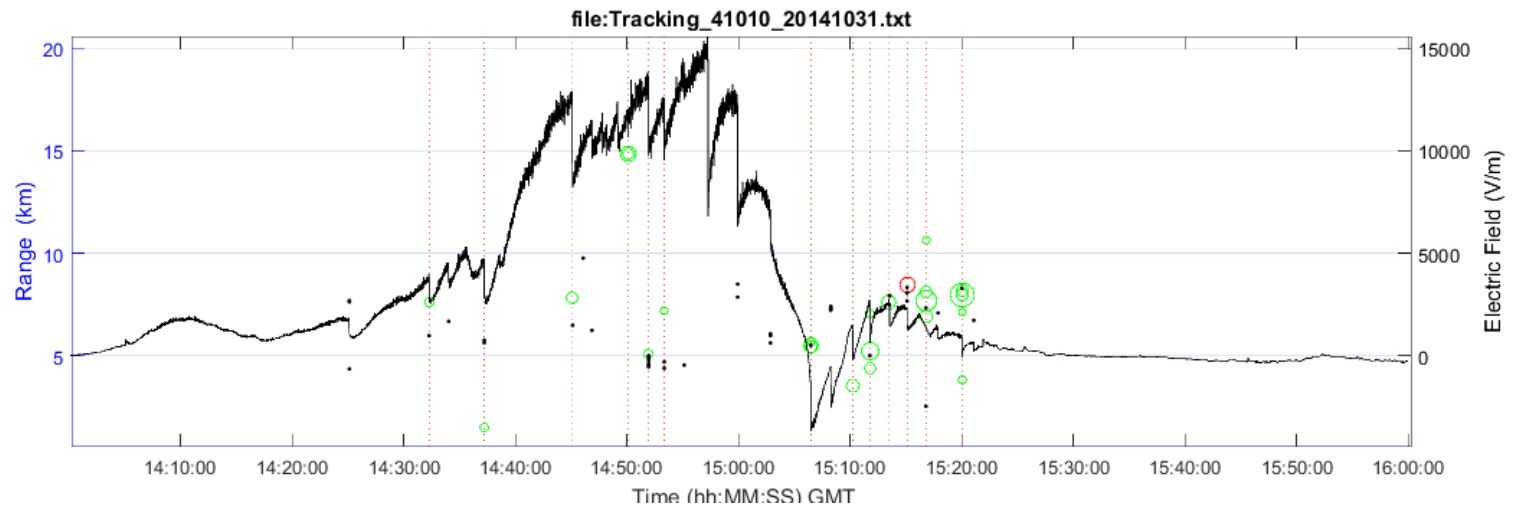
# 07-28-2014 Ocean (20 mi)



# 10/31/14 Deep Ocean



# 10/31/14 Deep Ocean





# Conclusions to date

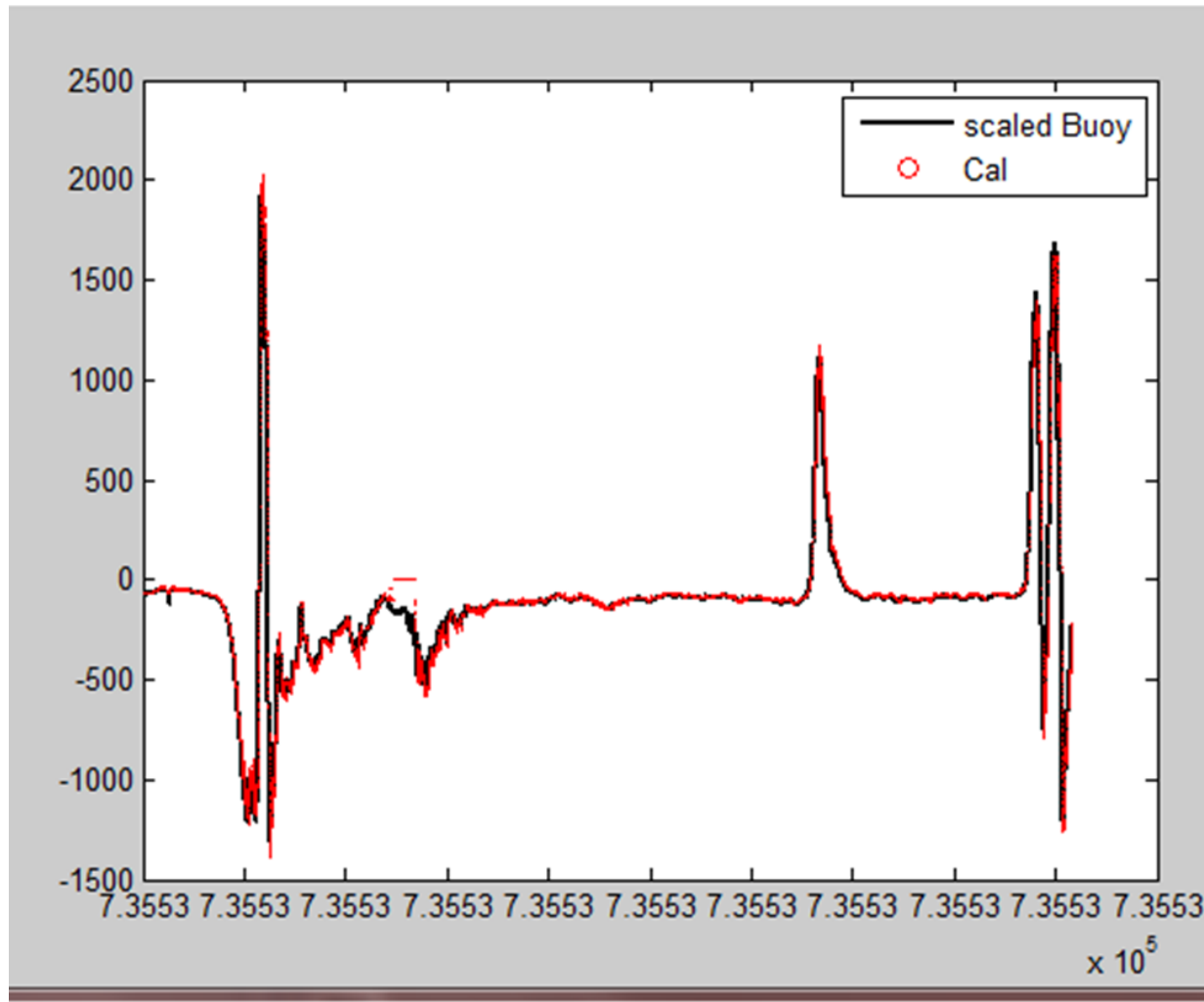
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1. Statistically larger  $I_p$ 's for both First In Flash originate over the ocean but  $I_p$ 's for Pre-Existing Channel were equivalent to those on-shore.
2. Storms consistently show higher E-fields over ocean during both high reflectivity and active lightning as compared to on-shore E-fields using the same criteria.
3. The influence of the classic lower positive charge layer that appears in on-shore electrified clouds was reduced or absent in isolated cells over the buoy during this study.

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# Back-up slides

# 10/22/13 0400-2300 GMT



# 10/22/13 0400-2300 GMT

